

New Zealand Rocks and Landforms

It is widely accepted that the rocks of New Zealand formed along Gondwana’s plate margin, representing one of the most extensive orogenic belts in Earth history. The margin was originally established by rifting 700 Million years ago (Ma), and became a long-lived site of subduction and plate convergence from about 500 Ma until 100 Ma ago. Accretion of arc-trench systems, and possibly micro-continental fragments, formed a series of eastward-younging orogenic belts. Original relative positions in the New Zealand sector of the margin have been disrupted by the opening of the Tasman Sea and the Southern Ocean after 85 Ma, followed by further disruption and re-configuration of the New Zealand microcontinent along the presently active plate boundary.

The modern day New Zealand landscape has been created by tectonic uplift and volcanic activity and fashioned by high rates of erosion. Currently, the Southern Alps are one of the fastest rising mountain ranges in the world. They rise at a rate of 4 – 12 millimetres per year, despite very rapid erosion due to heavy precipitation, glacial action and frequent landslides triggered by earthquakes.

As you walk **along the corridor** you are taking a journey through New Zealand’s geologic history. The granites, the plutonic roots of volcanic arcs, have been intruded into older sedimentary rocks and form the **basement** of New Zealand. The **cover rocks** have been deposited after the separation of New Zealand from Gondwana and consist predominantly of thick sequences of marine sediments. ‘Hot-spot’ **volcanism** occurred from 100 to 3 million years ago producing the Banks Peninsula, the headlands of the Otago Peninsula and many other volcanic fields. The gravels of the Canterbury Plains are the **youngest sediments** and formed during the last ice age through erosion of the Southern Alps.

BUILDING TOOLS



Folding
The term fold is used in geology when one or a stack of originally flat and planar surfaces, such as sedimentary strata, are bent or curved as a result of plastic (i.e. permanent) deformation. Folds in rocks vary in size from micro-scopical crinkles to mountain-sized folds.



Faulting
A fault or fault line is a planar fracture in rock in which the rock on one side of the fracture has moved with respect to the rock on the other side. Large faults within the Earth's crust are the result of differential or shear motion and active fault zones are the causal locations of most earthquakes.



Unconformity
An unconformity results from discontinuous deposition of sediments. An unconformity typically results when earlier sediments are eroded before being buried under sediments deposited during a later episode of sedimentation. In general, the term unconformity describes any break in the sedimentary geologic record. There are three forms of unconformities: *disconformity*, *nonconformity*, and *angular unconformity*.

SHAPING OF LANDFORMS



The New Zealand landscape is young in geological terms. It features a generally rugged, steeply dissected topography that has been created over the past several millions of years by progressive uplift of the continental landmass and by faulting and volcanism - processes closely related to tectonic activity along the Pacific – Australian plate boundary that runs through the country. The landscape is constantly changing, with uplift counter-balanced by rapid erosion added by high rainfall and periodic glaciations.

BASEMENT ROCKS

The basement rocks of New Zealand are variable in terms of age, composition and significance. They are divided broadly into a Western Province (Northwest Nelson, West Coast and Fiordland) consisting mainly of granite and gneiss, and an Eastern Province (Southland, Otago, Canterbury and most of the North Island) consisting mainly of greywacke and schist. They are also classified according to their main mode of formation - igneous (crystallized from magma), sedimentary (deposited as sediments) and metamorphic (recrystallized and hardened under intense heat, pressure and strain).



Plutonic (c. 350–83 Ma)
Plutonic rocks are igneous rocks that have solidified deep in the crust from hot (750–900°C) magma before they were able to erupt. The term granitoid is often loosely used for all plutonic rocks ranging from light-coloured granites to dark-coloured gabbros. Granites are some of the most distinctive basement rocks, exposed along the rocky coastline of the West Coast, Buller and northwest Nelson.



Sedimentary (c. 500Ma) (c. 300–100 Ma)
Greywacke – from the German, meaning ‘grey rock’ – is a hard, resistant sandstone. As the name implies, it is a typically greyish rock. Technically it is a sandstone composed of equal amounts of quartz, feldspar and fragments of pre-existing rocks. Greywacke underlies about 70% of the land area of New Zealand, making it the most common type rock in the country. High pressure, and temperature of up to 650°C in the crust, have changed the greywacke into schist. The **Haast Schist** is a 2000 kilometre long belt that extends from the Chatham Islands, through Otago, Wellington and on into the central North Island.

COVER ROCKS



Post-Gondwana sedimentary rocks (less than 100 Ma)
The period between 145 to 100 Ma was one of collision, uplift, volcanic activity and granite formation along the Gondwana margin. During this period of mountain building (orogeny) the eastern parts of New Zealand were created by the uplift of thick marine sediments. The orogeny was followed by a long period of tectonic quiescence, which lasted until 40–30 Ma. During this long period of erosion and subsidence the **coal measures** and **limestone** sequences of New Zealand were deposited. Compression along the Alpine Fault initiated at c. 23 Ma and by c. 5 Ma the Southern Alps have become a continuous belt.



VOLCANOES



Volcanic rocks (less than c. 23 Ma)
Minor volcanism related to the Gondwana break-up is confined to the South Island e.g., Mount Somers, Island Hills, Tapuenuku. Volcanism associated with mantle ‘hot-spots’ under southern New Zealand, away from the plate boundary subduction zones, has resulted in a broad volcanic province stretching from the Campbell Plateau, through eastern South Island to the Chatham Islands. The mainly basaltic volcanic activity occurred intermittently from c. 100 to 3 Ma ago, producing complex shield volcanoes such as those that form the headlands of the Otago Peninsula or the Banks Peninsula. Today's volcanism is confined to the Taupo Volcanic Zone in the North Island.

YOUNGEST SEDIMENTS



Youngest sediments (less than c. 2 Ma)
The gravels of the Canterbury Plains were deposited during the most recent ice age through erosion of the Southern Alps and its foothills. Rivers such as the Waitaki, Rangitata, Rakala and Waimakariri today continue to transport large amounts of sediments across the plains to the continental shelf.

TIME SCALE

EON	ERA	PERIOD	EPOCH	Ma	
Phanerozoic	Cenozoic	Quaternary	Holocene	0.01	
			Pleistocene	1.8	
		Tertiary	Neogene	Pliocene	5.3
				Miocene	23.7
			Paleogene	Oligocene	33.7
				Eocene	54.8
				Paleocene	65
				Mesozoic	Cretaceous
		Jurassic	206		
			Triassic		248
		Paleozoic	Permian		290
			Carboniferous		354
					Devonian
			Silurian		443
	Ordovician		490		
	Cambrian		543		
			Precambrian	Proterozoic	Late
	Middle				1600
	Early	2500			
	Archean	Late		3000	
		Middle		3400	
		Early		3800	